AN EVALUATION OF THE NOAA WEATHER-CHEMISTRY MODEL DURING THE NOAA NEW ENGLAND FORECASTING PILOT PROGRAM AND THE TEXAS AQS 2000 FIELD EXPERIMENT

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Motivation: To evaluate the performance of NOAA's coupled weather-chemistry model in two field experiments of regional real-time air-quality forecasts for the purpose of improving operational quantitative air-quality forecasts.

Numerical Model: The coupled weather-chemistry forecasting model combines a modified version of the fifth-generation Penn State/NCAR Mesoscale Model (MM5) and the chemical mechanism of the Regional Acid Deposition Model Version 2 (details about the coupled model can be found in Grell et al.2002). The transport of chemical species (grid-scale and sub-grid scale) is treated simultaneously with meteorology. Photolysis, biogenic emissions, and deposition are also calculated "online". The model was run on multiple 1-way nested meshes of 27 km, 9 km, and 3 km for the New England study and 60 km, 15 km, 5 km, and 1.67 km resolutions for the TEXAS AQS study. The coarsest meshes were initialized using the Forecast Systems Laboratory/Rapid Update Cycle (FSL/RUC) analyses. The boundary conditions are provided by NCEP's ETA model forecasts. The chemical fields are initialized with the previous forecast to take into account the effect of accumulation. The emission input was compiled by using current federal and state emission inventory databases.

NEW ENGLAND

The New England Air Quality Study (NEAQS) and New England Temperature Air Quality Pilot Study (TAQ) experiments were carried out during Summer, 2002. Realtime forecasts from NOAA's coupled weather-chemistry model are compared with wind profiler and surface ozone measurements that were available in real-time during a high surface ozone episode that occurred on 13-14 August 2002.

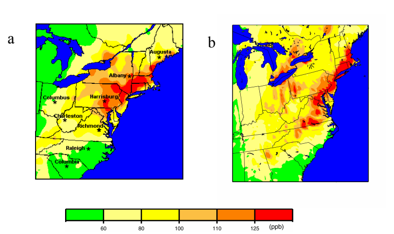

Figure 1

Figure 1. (a) Observed 1 hour peak ozone concentration (from EPA website, http://www.epa.gov/cgi-bin/airnow.cgi) for 14 Aug; (b) Forecasted 1 hour peak ozone concentration on the 27 km grid of NOAA's coupled weather-chemistry model (both in ppb).

Figure 2. (a) Time-height series of observed wind profiler winds and signal to noise ratio (SNR) at Concord, NH from 00 UTC 13 – 00 UTC 15 Aug 2002; (b) Time-height series of winds from the 27 km grid of NOAA's coupled weather-chemistry model at Concord (model initialized at 00 UTC 13 Aug 2002). Dots indicate planetary boundary layer (PBL) height.

Figure 3. Time-height series of observed wind profiler winds and RASS temperatures during the same time period as Fig. 3; (b) Same as (a) except from the 27 km grid of NOAA's coupled weather-chemistry model. Dots indicate planetary boundary layer height.

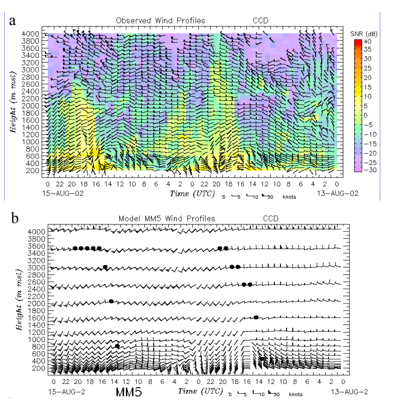

Figure 2

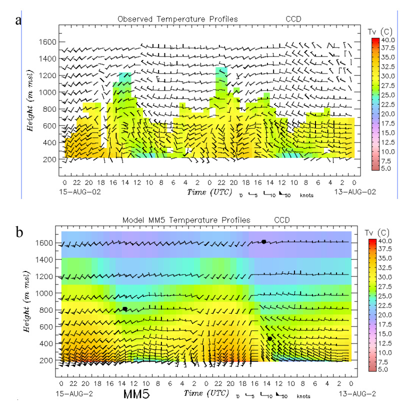

Figure 3

TEXAS

The Texas Air Quality Study 2000 (TEXAS AQS 2000) was carried out in August and September of 2000 in the Houston metropolitan area by a team of researchers from federal and Texas state agencies, and universities. Real-time forecasts from NOAA's coupled weather-chemistry model are compared with wind profiler, aircraft, and rawinsonde measurements taken during a high surface ozone episode that occurred between 25- 30 August 2000.

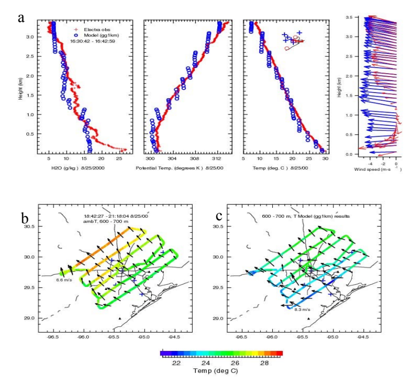

Figure 4

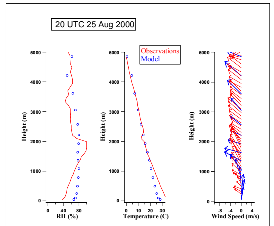

Figure 5

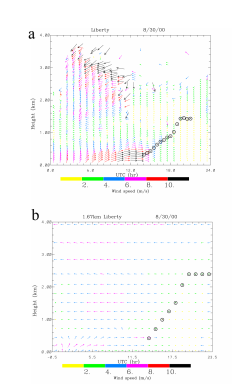

Figure 6

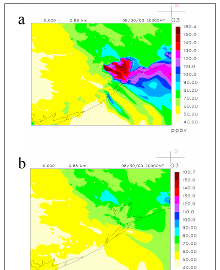

Figure 7

Figure 4. Comparison of model forecasts with aircraft data on August 25, 2000. (a) sounding comparison of water vapor mixing ratio, potential temperature, temperature, and winds; (b) observed temperature and winds along the Electra flight path between 600-700 m; (c) same as (b) except for model forecasted temperature and winds (from the 1.67 km grid).

Figure 5. Comparison of model (at 1.67 km grid resolution) with rawinsonde data taken at (29.95° N, 95.54° W). Left panel is the comparison of RH (%) with height, middle panel is the comparison of temperature (C°) with height, and the right panel is the comparison of wind vectors with height. Red is observations and blue is model.

Figure 6. (a) Time-height series of wind profiler observations at Liberty, TX. Circles denote the PBL height; (b) Same as (a) except the winds and PBL heights are from the model.

Figure 7. (a) Surface ozone concentration (ppb) on the 1.67 km grid with the improved olefin emission rate in the chemical model; (b) surface ozone concentration from the original real-time model run.

DISCUSSION

New England:

Preliminary comparison suggests that the forecasted cycle of low-level winds during the 48 hour period is in fairly good agreement with observations. However, the forecasted low-level winds appear to be faster than observed with some differences in the wind direction and the forecasted temperature tends to be too warm in the boundary layer. Both forecasted and observed 1 hour peak ozone concentrations have concentrations in the northeast of over 125 ppb. However, the highest concentrations in the model tend to be more towards the southeast than what was observed. More detailed comparisons with observations and statistical evaluation of model performance will be carried out in the near future.

Houston:

The forecasted land-sea breeze cycle is in good agreement with the wind-profiler observations, but differences exist in the wind direction and speed. The forecasted strength of the nocturnal low-level jet agrees fairly well with observations. However,the forecasted direction is more easterly than observed. The forecasted PBL mixing layer generally grows faster and deeper compared with observations, although the on-set of the PBL growth does compare well with observations. The comparison of the model output with both aircraft and rawinsonde observations indicates that model forecasts possess a cold bias at low levels. The investigation of the impact of surface emission inventory on chemical forecasts has revealed that the original emission input used in the real-time forecasts during TEXAQS 2000 had an unreasonably low emission rate of olefin. After the emission input is improved, the forecasted low-level ozone concentration becomes much closer to the observed value than with the old emission input that was used during TEXAQS 2000.